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STRUCTURAL & CIVIL ENGINEERING DESIGN CONSULTANTS

PROPOSED NEW RESIDENTIAL 2 DEVELOPMENT ON PORTION 91 OF FARM 304 MATJIESFONTEIN

BULK SERVICES AND CIVIL ENGINEERING INFRASTRUCTURE REPORT

Project No 23G210

ISSUED FOR REZONING APPROVAL

Version 5 June 2024

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PROPOSED NEW RESIDENTIAL 2 DEVELOPMENT ON PORTION 91 OF FARM 304 MATJIESFONTEIN

BULK SERVICES AND CIVIL ENGINEERING INFRASTRUCTURE REPORT

1. INTRODUCTION

Portion 91 of the Farm 304 Matjiesfontein is to be rezoned for Residential 2 development.

The total area of the site is approximately 14 hectares. Approximately 8.6 hectares of the site comprises steep forested area which will be preserved in its natural state. The Development area, covering of total 4.86 hectares, will be situated within the remaining area. The development will comprise 60 Residential 2 erven of average size 475 square meters.
The Developer has appointed Poise Consulting Engineers to attend to the design of the civil engineering services for the development.

This report addresses the sewer and water connection requirements and capacities for the new development and summarizes the proposed road access and stormwater management principals to be adopted.

This report is submitted for Re-Zoning approval purposes.

2 SITE DESCRIPTION

The site is situated on the northern side of Keurboomstrand Road MR395 approximately 2 kilometers south of Keurboomstrand Village.

Access will be off Road MR395

The approximate coordinate of the centre of the site is 34° 00' 18" S and 23° 26' 10" E.

Topography:

The northern forested area of the site is extremely steep at a gradient of approximately 50%. This area will be preserved and not affected by the development.

The area of the site to be developed slopes from north to south at an average gradient of approximately 1,5%, with a small area in the north east corner increasing to 12%.

Soils:
The site to be developed is blanketed by estuarine/alluvial sand deposits overlying sandstones. The soil drainage characteristics are permeable.

Vegetation:
The northern area of the site which will be preserved and not be affected by the development is densely forested.

The southern area of the site is generally grassed lands.

3. DESIGN STANDARDS

The following design standards will be applicable:

- Guidelines for Human Settlement Planning and Design, compiled for the Department of housing by the CSIR (Red Book)
- Relevant specific specifications of the Bitou Engineering Services Department

4. WATER RETICULATION

Water Connection
The water connection for the development will be off the existing 200mm watermain in Keurboomstrand road. See Figure 1 of the attached GLS report

Water Demand
The water demand is based on average daily demand of 600 litres per erf and 60 erven

Average Daily Demand : 36 kl
Based on a peak factor of 4 the maximum peak flow demand will be 1,7 litres per second.
The fire flow criteria is Low Risk Group 1 which requires provision for a fire flow of 15 litres per second with a minimum residual head of 10 meters.

Impact on Capacity

The development falls within the Matjiesfontein Reservoir distribution zone with a static head of 55.5m MSL.

The GLS Capacity Analysis Report confirms that the existing reticulation system and reservoir has sufficient capacity to service the Development

There is however insufficient capacity in the bulk water mains serving the reservoir, to maintain the required reservoir storage during peak seasonal periods. The Bitou Municipality have confirmed that Masterplanning is in place for the necessary upgrades to the bulk supply system. However the implementation of upgrades is entirely dependent on the availability of finance, and no time frame can be guaranteed for such implementation.

Alternative Water Sourcing
The above demand figures represent the worst case demand from the municipal system. The Developer's intent is to optimise the use of rainwater harvesting for domestic use and the use of treated greywater for irrigation purposes, within economic feasibility.
Detailed solutions will be addressed in the detailed design stage and will be to Bitou Engineering Department approval.

Internal Reticulation
The internal water pipes will remain the property of the development and will not be taken over by Bitou Municipality. The domestic internal water reticulation system will be of Class 9 UPVC pipes of up to 110mm diameter. Minimum cover to watermains will be 800mm.
Fire Hydrants will be provided at maximum 180m intervals
The reticulation system will be designed to provide for a minimum residual head of 24m under peak domestic flow conditions, and 15m under peak domestic plus fire flow conditions.

Construction of all watermains and connections will be in accordance with Bitou Municipality and SABS 1200 specifications.

5. SEWER RETICULATION

Sewer Connection
The sewer connection for the Development will be to the existing 160mm reticulation pipe situated immediately opposite the site on the southern side of Keurboomstrand Road. See attached GLS Figure 4.

Sewerage Discharge
The sewerage discharge demand is based on average daily discharge of 480 litres per erf and 60 erven.

Average Daily Discharge: 28,8 kl
Based on a peak factor of 2.5 the maximum peak discharge will be 0,8 litres per second.

Impact on Capacity
The Development falls within the drainage area of the Keurboomstrand main pump station. Effluent from this pumpstation is routed to the Municipal Ganse Valley wastewater treatment plant through the Matjiesfontein and Aventura pump stations and their respective rising mains.
The GLS Capacity Analysis report confirms that the pump stations have sufficient capacity to accommodate the Development.
However certain rising main upgrades are required and the wastewater treatment plant is currently at full capacity.

The Bitou Municipality have confirmed that Masterplanning is in place for the necessary upgrades to the bulk sewerage system. However the implementation of upgrades is entirely dependant on the availability of finance, and no time frame can be guaranteed for such implementation.

Interim Alternative Sewerage Treatment
Until such time as the necessary upgrades have occurred to the Bitou bulk sewerage system, the sewerage will be treated using an on site sewerage package plant. The plant type to be used will be a Bio Sewage Systems 30 kilolitre per day plant or similar approved.

The Bio Sewage Plant:

The Bio Sewage Systems plant is a containerized bio reactor plant which delivers treated sewerage to the DWAS special limits water quality standard. Bio Sewage Plants are environmentally friendly, chemical free, robust and have been proven to be reliable and simple and easy to maintain. Sludge is recycled within the plant system and there is therefore no requirement for cleaning and sludge removal. This is confirmed by Bio Sewage Systems plants which have been operational for in excess of 15 years with no sludge removal requirements.

The raw sewage will discharge to an anaerobic underground tank from where it will be pumped to the containerised plant. The plant will operate on an “equals in equals out” basis, however, the preceding anaerobic tank will be designed with sufficient capacity to cater for offline situations and will include for emergency storage of 48 hours. That is 60 kilolitres.

The anaerobic tank will be the only underground component of the Plant. The tank will be constructed of reinforced concrete including Penetron Admixture. The durability will therefore be in excess of 50 years, but effectively infinite.

A subsurface drainage system will be installed beneath the anaerobic tank, including a pump sump from which any leakage can be returned to the tank. The drainage system will have an impermeable lining beneath it designed such that that no leakage will infiltrate the ground below.

Plant Effluent:

The treated discharge from the plant will be pumped to an elevated holding reservoir, also of capacity 60 kilolitres, and situated in the north west corner of the developed area. From this reservoir the effluent will be reticulated with each erf being provided with a connection for irrigation and toilet flushing.

The estimated total average daily usage for toilet flushing will be approximately 7,5 kilolitres, based on an average of 3 occupants per house.

Disposal by irrigation of the remaining 22,5 kilolitres per day would require an average irrigation rate of only 2 mm per square meter over the total potential irrigatable area, which is approximately 1.12 ha.

Excess effluent will be discharge to the stormwater detention ponds system. This will be environmentally acceptable, the effluent being to DWAS Special Limits quality.

Plant Maintenance

Plant care will be included in the job responsibility of the Estate maintenance manager, who will be trained accordingly and will visit site and inspect the plant on a daily basis.

Pre-treatment screening will be provided which will facilitate the cleaning and removal of non bio-degradables. The frequency of cleaning will be determined once the plant is in operation and the amount of non-biodegradables being screened. The non-biodegradables removed would be sent for incineration at a recognised waste disposal site.

To enable the monitoring of any potential failure and consequential overflow of the system, an emergency alarm will be installed which will be activated once effluent level rises in the emergency storage component of the system.

All required regular maintenance can be done within the 48 hour emergency storage period. In the event of any abnormal extended maintenance period arising, effluent removal tanker services will be engaged.

Effluent quality will be tested on a monthly basis.

The plant will be powered by a Solar/Eskom charged battery system with a backup generator for emergency supply in the event of extended Eskom down time.

Plant Approvals:

The detailed designed of the overall system will be to Bitou Engineering Department approval

Bio Sewage Systems have been established for over 20 years and have over 800 plants, of size ranging from 5 to 200m3 per day, operating in Southern Africa. Whilst the majority of their plants are outside of Municipal areas, it is notable that that they have had plants approved by both eThekwini and Cape Town Municipalities.

The preliminary positioning of the plant and effluent storage reservoir are indicated on attached DWG No: 23G210 S01. The Bio Sewage method statement and Activated Sludge Handling Process is also attached.

Internal Reticulation
The internal sewer pipes will be the property of the development and will not be taken over by Bitou Municipality.

The internal sewer reticulation system will be of 160mm Class 34 UPVC sewer pipes. Manholes will be of precast concrete ring structures, in accordance with SABS 1200D standards. Manholes will be provided at a maximum of 80 meter intervals.

Minimum cover to sewers will be 1000mm under roadways and 700mm elsewhere.

The internal system will drain to the Bio Sewage Systems Plant positioned centrally on the southern boundary of the site.

In the future, when the necessary municipal upgrades have been implemented the system will be connected to a pump station adjacent to the sewerage plant, from where the discharge will be pumped to the connection point on the existing reticulation system situated immediately opposite the site on the southern side of Keurboomstrand Road.

Construction of all sewers, connections and manholes will be in accordance with SABS 1200 specifications

6. ACCESS

The site access will be off Keurboomstrand Road MR395
Any road widening or sliplane requirements will be dealt with in a Traffic Impact Assessment to be undertaken after the pre=application stage.

7. INTERNAL ROADS

Internal roads will be private roads and will not be taken over by Council

Pavement and Geometric Standards
The development will include the following roads which will be classed as follows:

Description	Width	Category/Class
Main Access Collector	5,5m	UC/ES1
Internal Access Roads	4,0/5.0m	UC/ES0,3

The minimum bellmouth radii will be 7.5m

Kerbs
The main access will have standard SABS figure 7 pre-cast concrete semi mountable on both sides. The internal roads will have edgings on the high side and mountable kerbing on the low side of the crossfall.

8. STORMWATER MANAGEMENT

The permeable conditions of the site allow that in the current state all rainwater falling on the site discharges through infiltration within the defined area of the site. There is insignificant overland discharge of runoff from higher lying areas to the lower lying areas of the site

Site Area Excluded from Development

The total area of the site to be excluded from development is approximately 9.14 hectares

In the post-development state, rainfall over the undeveloped areas will continue to discharge via infiltration over those areas.

Site Development Areas

The total area of the site to be developed is 4.86 hectares

The stormwater will be managed such that developed erven will generally discharge to the road surfaces which in turn will discharge through permeable paving to one of three retention ponds which will be provided.

Because the site is very flat underground stormwater pipes will not be feasible. The positions of the ponds are however such that the road surfaces will have sufficient capacity to contain the runoff on surface and discharge it to the ponds without flooding.

The overall area affected by the development will have an impermeability ratio of approximately 45 percent. This impermeability ratio does not increase the total discharge volume of the site, but does reduce the available infiltration area, and therefore increases the duration of infiltration.
Containment of the excess discharge within the ponds, will allow for the longer discharge infiltration time.

Stormwater Modelling

The runoff and retention calculations have been done utilising the CBA Hydrograph Generation Reservoir Routing program of Chris Brooker and Associates.
The average annual precipitation is 650mm.

In calculating the run-off coefficient for the site in its natural state the following factors were used:

- Slope C_S 0.02
- Permeability C_P 0.04
- Vegetation C_V 0.20

Using an adjustment factor of 0.83 the coefficient C for the 50 year storm is 0,22.
Based on the average post development impermeability ratio of 45% the post development discharge coefficient is 0,57.

The post-development runoff time of concentration is 15 minutes. The generated runoff data is however based on a storm duration of 100 minutes, which is the duration which renders the maximum retention conditions.

For calculation of the discharge from the ponds, an infiltration rate of 5 centimeters per hour has been adopted.

Rainfall Volumes and Retention Data

The attached Stormwater Management Data Table indicates the areas of the 3 catchments, the pond areas, the 24 hour runoff volumes and the maximum stored volumes, for the 1 in 50 year return interval storm.

The data indicates that the retention ponds will have considerably more storage capacity than the modelled requirements, all with a minimum factor of safety of 2.

Because there is no current and will be no post development discharge of stormwater to outside of the site boundaries the normal required stormwater attenuation parameters are not applicable to the stormwater management plan.

The post-development Catchment Areas and ponds are indicated on attached Figure 2.

Sustainable Drainage Systems (SUDS)

Discharge from road areas to retention ponds will be through permeable paving with designed area requirements in order to provide the regulatory SUDS reduction specifications. The details of these requirements will be addressed in the detailed design stage.

9. SERVICES AGREEMENT

A pre-requisite for implementation of the Development will be the conclusion of a Services Agreement with the Bitou Municipality.

The services agreement will define the applicable development parameters relating to sewerage, water, electricity, stormwater management, internal roads and access.

The Bitou Municipality have confirmed that although Masterplanning is in place for the necessary bulk sewerage and water upgrades, the timing of the implementation of upgrades is entirely dependent on the availability of finance.

The conclusion of the Services Agreement and the implementation of the Development can therefore only occur when the bulk sewerage and water ugrades necessary for the Development have been implemented by the Municipality.

9. Attachments

DWG No: 23G210 S01 General Layout: Roads, Stormwater, Sewer and Water Reticulation.
Figure 2 Stormwater Catchment Areas
Stormwater Management Data Table
GLS Bulk Services Analysis Report
GLS Figure 1
GLS Figure 4
Bio Sewage Method statement
Activated Sludge Handling Process

Prepared By: Date: 18 June 2024

D Botes Pr.T Eng..

PLAN: Scale 1:1000

LEGEND

- ROADWAY
- ROAD/POND SW OUTLET
- UPVC WATER
- FIRE HYDRANT
- GATE VALVE
- BULK WATER METER
- ø160 UPVC SEWER
- SEWER MANHOLE
- TREATED EFFLUENT RISING MAIN
- EFFLUENT IRRIGATION RETICULATION
- BIO SEWAGE TREATMENT PLANT
- SEWER PUMP STATION

DETENTION POND AREAS AND VOLUMES

POND 1	2031m2	1523m3
POND 2	1265m2	949m3
POND 3	735m2	368m3
TOTAL	4031m2	2840m3

POTENTIAL IRRIGATION AREAS

INDIVIDUAL GARDENS 60 @ Ave 200m2	1200 m2
ROAD VERGES	5017 m2
GREENBELT AREAS EXCLUDING PONDS	4997m2
TOTAL	11214m2

Project

PORTION 91 OF THE FARM 304
MATJIESFONTEIN

Description

GENERAL LAYOUT
ROADS STORMWATER SEWER AND WATER RETICULATION

REV.		DATE
E	POND AND IRRIGATION AREA TABLE REVISED	18 04 24
D	POND AND IRRIGATION AREA TABLE ADDED	01 04 24
C	LAYOUT REVISED FOR BIO SEWER	09 04 24
B	LAYOUT REVISED RE-ISSUED FOR APPROVALS	28 10 23
A	ISSUED FOR APPROVAL	02 04 23

DRAWN BY: PB CELL:

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JOB No	DRW No	REV	DATE
23/G210	S01	E	08-04-2024

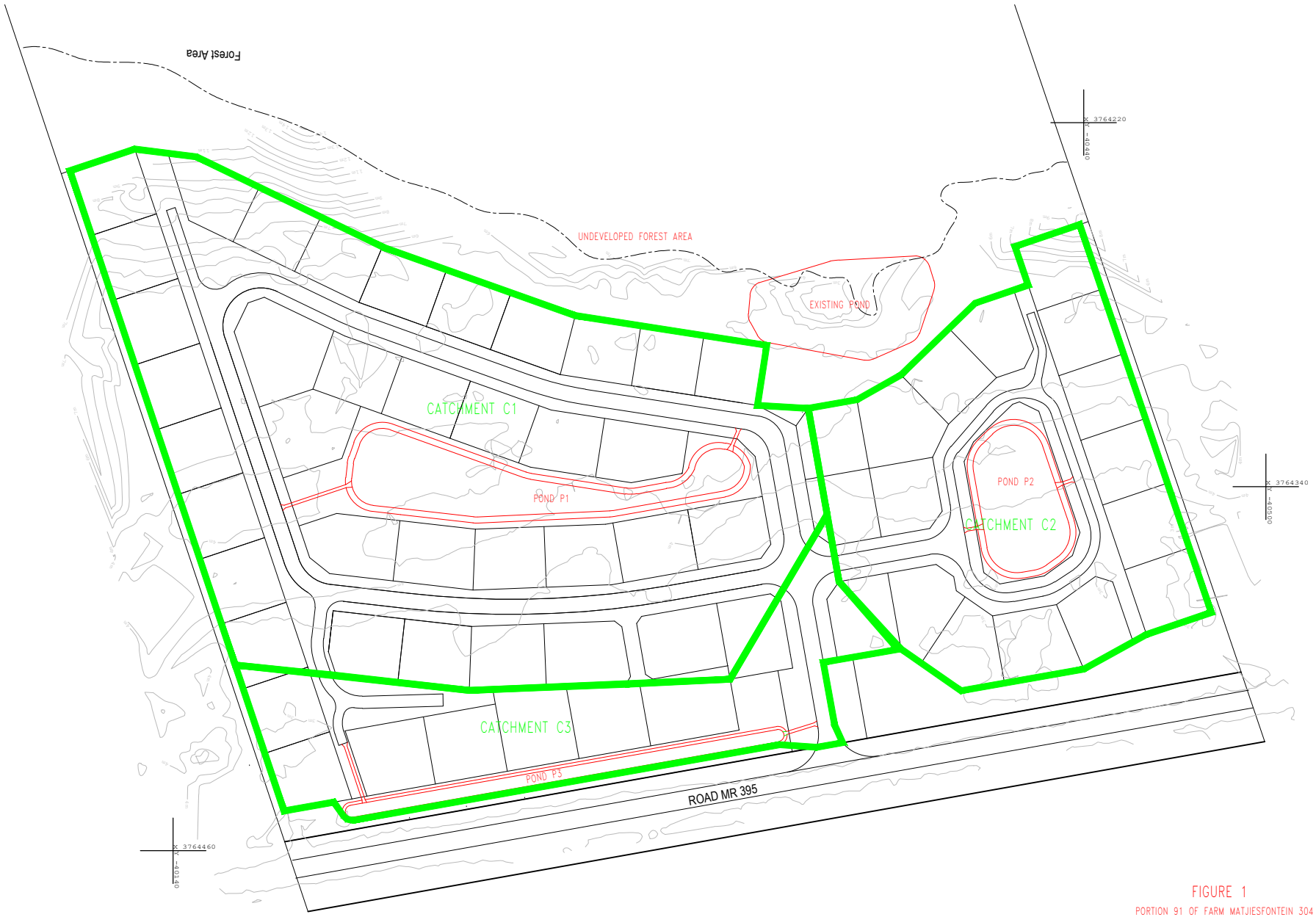

FIGURE 1

PORTION 91 OF FARM MATJIESFONTEIN 304
POST DEVELOPMENT CATCHMENT AREAS

STORMWATER MANAGEMENT DATA TABLE
PORTION 91 OF FARM 304 MATJIESFONTEIN

CATCHMENT AREA	AREA	POND NO	POND AREA	POND DEPTH	INFILTRATION CAPACITY @ 5cm/hr	1:50 YR 24hr RAINFALL VOLUME	1:50 YR PEAK RETENTION VOLUME	TOTAL POND VOLUME	RETENTION VOLUME FOS
No	Ha		m2	mm	m3/hr	m3	100min m3	m3	
1	2,861	P1	2031	750	102	2213	695	1523	2,2
2	1,238	P2	1265	750	63	958	258	949	3,7
3	0,759	P3	735	500	37	587	163	368	2,3

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SBR Sludge Handling

In a traditional SBR (sequential batch reactor) a flocculant is introduced into the process to facilitate sludge separation. After flocculation the clear treated effluent is drawn off from the reactor and a portion of floating and settled sludge is decanted into sludge drying beds where the sludge is dried out. As this dried sludge is not sterilized it is either disposed of in a municipal dump site or it goes through an extruder and oven to sterilize.
This is obviously very inefficient, expensive and time consuming to achieve. Additionally, it requires a large footprint for the drying beds as well as labour intensive to process the dried sludge.

Activated Sludge Handling

Activated sludge consists of sludge particles, teeming with living organisms, produced in either raw or settled wastewater by the growth of organisms (which include bacteria) in aeration tanks where dissolved oxygen is present.

The Activated Sludge Process is one of several biological wastewater treatment alternatives in Secondary Treatment. When Activated Sludge is added to wastewater, the organisms in this mixed liquor quickly decompose the wastes in the wastewater being treated. After a required period of aeration and agitation in the aeration reactor, the mixed liquor flows to a separate tank called a clarifier where the activated sludge is allowed to settle out and the remaining liquid is discharged as effluent.
The settled waste activated sludge is then reused in the aeration tank as return activated sludge. This sludge must always be returned to the aeration reactors to maintain an adequate population of organisms.

Oxidation and removal of soluble or suspended solids is the result of the activated sludge process. This treatment takes place in a few hours in an aeration tank.
Stabilized soluble or suspended solids occur when organisms partially oxidize solids. Organism activity forms carbon dioxide, water, sulphate, and nitrate compounds.

The MBBR (moving bed bio reactor) process, as used by **Bio Sewage Systems,** uses these microorganisms to speed up decomposition of wastes. This “food” is known as Biochemical Oxygen Demand (BOD). BOD is the measure of oxygen demand in the incoming wastewater. A strong wastewater will have a high demand, whereas a weak wastewater will have a lower demand.
BOD is the measure of how much oxygen it will take to stabilize the waste (or food) that is in the wastewater.

Organism mass is called Mixed Liquor Volatile Suspended Solids (MLVSS). The overall concentration of suspended solids in an aeration tank is called Mixed Liquor Suspended Solids (MLSS). This consists mostly of microorganisms and non-biodegradable suspended matter. When wastewater is added to activated sludge, microorganisms feed and grow on waste particles in the wastewater. As the organisms grow and reproduce, waste is removed and wastewater is partially cleaned. Organisms need a balance of food (BOD) and oxygen. BOD is inherent in the wastewater and oxygen is added by aeration equipment.

By this process the activated sludge harvested is fed back to the beginning of the process, which initiates the ammonia breakdown, the nitrification and denitrification processes and is ultimately reduced to nothing. The BSS system is therefore a closed loop system mitigating any expensive sludge processing requirements.

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Method Statement of Bio Sewage Systems Waste Water Treatment Plant Operation

1) The primary treatment consists of a septic/collection tank with two chambers that receives the raw untreated sewage from source. Most of the settleable solids accumulate in the first compartment from where the settled sewage flows into the second compartment. The inorganic material (items that can't be processed) remains in the first chamber.
   The organic material in the sewage is reduced as a result of sedimentation and anaerobic digestion. The septic tank is designed to have sufficient storage capacity to act as a buffer and thereby smooth out fluctuations in flow and to store waste water in the event of a power interruption.

2) The septic/collection tank is fitted with a submersible pump which is used to transfer the settled and partially treated waste water into the sewage treatment plant.

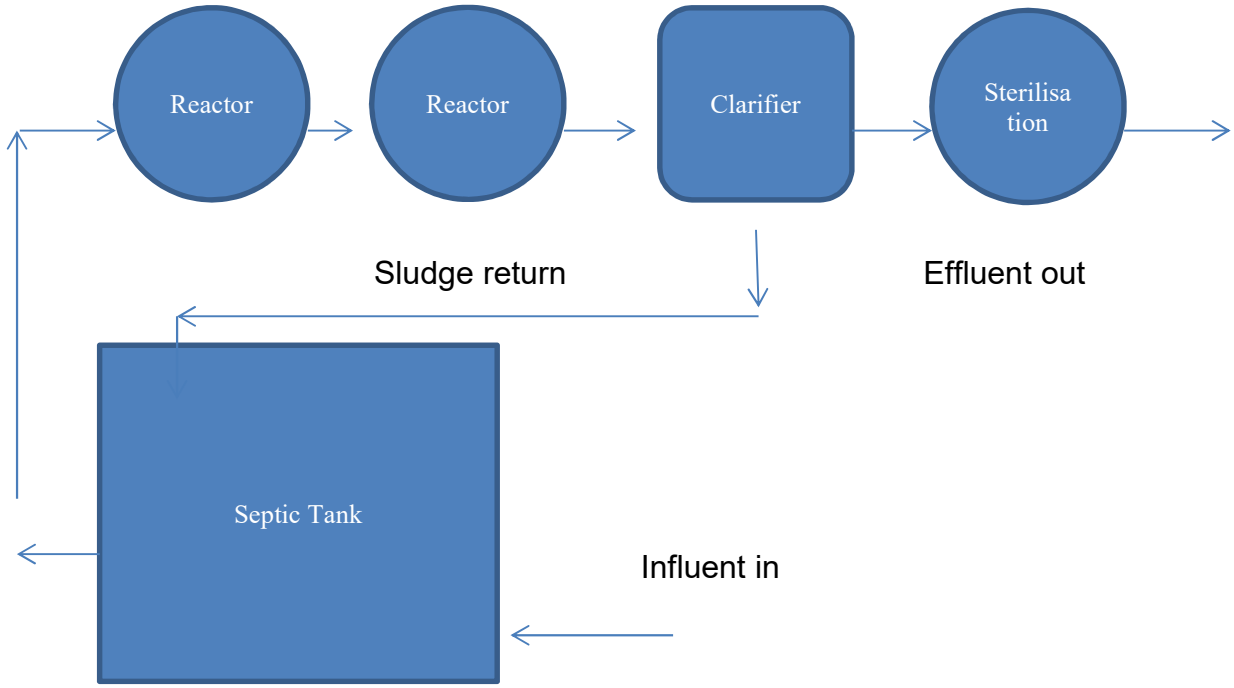
   The plant consists of various processing stages.

   a) Ammonia (NH_3) is a nitrogenous compound that is oxidized in a process called **nitrification**. The nitrification of wastewater is necessary to remove or reduce the amount of nitrogen compounds in wastewater. These compounds act as environmental pollutants. Nitrification occurs when nitrifying bacteria converts ammonia and other nitrogen compounds into **nitrite** (NO_2) and the conversion of nitrite into **nitrate** (NO_3). The nitrification process converts ammonia into nitrate. After nitrification, **denitrification** must occur to remove nitrate from wastewater. Denitrification is an anaerobic process that reduces nitrate into molecular nitrogen (N_2) gas that vents to atmosphere.
      This process occurs in the septic/collection tank and bioreactors. The number of bioreactors is dependant on inflow volume and are arranged in series. In each of the biological reactors, floating media is used to provide sufficient surface area to support the attached biomass required to facilitate the nitrification process of the sewage. The bioreactors are fitted with aeration devices. Aeration of the wastewater is necessary to remove ammonia before the effluent is discharged. Surface turbulence caused by aeration releases or strips the ammonia molecules from the wastewater solution into the atmosphere through bacterial process. Due to this aeration a high concentration of biomass (bacteria) is retained in the reactors improving efficiency.

The majority of the biomass is attached to the media while a small fraction remains in suspension. By reducing the suspended solids concentration in this manner, the settling rate of sludge will be higher and a low sludge volume will be ensured. The settling time is reduced while a high effluent quality will be ensured. Another advantage is that the time for nitrification, which contributes largely to the reaction time, is significantly reduced.

b) The flow from the final aerated bioreactor enters a clarification/settling tank. The suspended solids (sludge) is allowed to settle and collect in the hopper of the clarifier. The sludge is then returned to the septic/collection tank daily where the activated sludge begins the nitrification/denitrification of the raw sewage. With this process it ensures the system is a closed loop system with no sludge generation as it is reprocessed. This mitigates the necessity of sludge drying beds and sludge handling which is onerous and requires a large footprint and is labour intensive.

c) The clear effluent then flows into a sterilisation tank for disinfection. Ozone is used for disinfection. The ozone destroys any remaining coliforms, hormones and any other harmful by-products of sewage. The benign disinfected water is then either stored for irrigation, released into the environment or can be re-used as grey water for flushing.



BIO Sewage Systems
The way nature does it.

Advantages

GREEN

- Recycles Black and Grey water - Allows greatly reduced consumption of municipal water
- Environmentally friendly - No sewerage contamination of the environment, underground water or open water sources
- No chemicals used at all in the process
- Very small footprint

ECONOMICAL

- Very cost effective, the R/litre rate is a fraction of a commercial system
- Very quick to install with minimal civil works
- Simple and 100% natural process
- Very light on electrical consumption
- Can be run off solar power
- Fully designed and manufactured in South Africa

SOCIO-ECONOMIC BENEFITS

- Human dignity
- Better Sanitation for WASH program, especially in areas that have no water borne sewage systems.
- Job creation through micro-contractors
- Can be used in both rural and densely populated urban areas

LOW MAINTENANCE

- No sludge handling required
- Unskilled monitoring of plant
- No chemicals or additives
- Replacement of any failed pumps simple and economical

WATER USAGE

- Low fresh water consumption
- Processed water can be re-used for toilet flushing
- Processed water can be used for irrigation or gardens, lawns and crops
- One litre of sewage produces one litre of processed water